

MULTIPLE SENSOR HEAT ALARM

Field of the invention

This invention relates to heat alarms to protect occupants of a vehicle or other enclosed space from prolonged high ambient temperature.

Background of the invention

Law Enforcement agencies, including private/government agencies, typically have a special detachment of employees that are assigned a trained dog. These detachments are referred to as K-9 units. The care and maintenance of the K-9 is of primary importance to the officer and the department.

As part of the special equipment, the K-9 unit has customized vehicles for transporting the dog along with his handler. However, there are times during the work day when it is necessary for the officer to leave the dog in the vehicle and conduct business alone. Usually, the vehicle is locked and ventilation is limited to prevent unintended contact between the dog and the general public. During the summer months or other times of higher than normal temperatures, especially sunny days, the interior of the vehicle may become too hot for the health of the dog.

There are temperature sensors on the market for use in K-9

1 vehicles. The units have a temperature sensor to be placed near
2 or in the K 9 containment area and connected by wire to a
3 display/control head mounted in the instrument panel.

4 The conventional sensors do not always give a true reading
5 of the ambient temperature in the vehicle and can give false
6 warnings. The placement of the sensor causes the inconsistent
7 readings either because of the location of the vehicle relative
8 to the sun or the surrounding structures. For example, if the
9 sensor is in direct sunlight it will read a higher temperature
10 than if it were in the shade.

11 Known prior art employ backup temperature sensors that are
12 manufactured at a fixed threshold that is inherent to the
13 materials used when manufactured. They are not intelligent or
14 settable. No reading can come from such a sensor nor can the
15 threshold be altered. Another commercial temperature sensor
16 has a second sensor located in the control head. This second
17 sensor serves as a back-up or over-ride and may be set at a
18 higher alarm temperature. There is no read-out for the over-
19 ride and it is located in or on the dash of the vehicle which is
20 one of the hottest locations. While there are two temperature
21 sensors, each can cause a false alarm because of their
22 respective locations.

23 U. S. Patent No. 5,793,284 discloses a temperature sensor
24 and a remote paging receiver and transmitter to notify an absent

1 operator when vehicle temperature is outside a predetermined
2 temperature range.

3 U. S. Patent No. 5,793,291 discloses a motion sensor and a
4 temperature sensor with preset extremes. The device will
5 transmit an alarm signal such as the vehicle horn when the
6 extremes are exceeded.

7 U. S. Patent No. 5,659,289 discloses a canine alert system
8 which operates a pager or beeper is based on temperature
9 sensing, air conditioning failure and engine stall.

10 U. S. Patent No. 4,663,626 discloses a device for operating
11 a vehicle power assist member from outside the vehicle.

12 U. S. Patent No. 4,183,177 and U. S. Patent No. 5,369,911
13 disclose a remote controlled auto door opening system for
14 unlocking and unlatching a vehicle door.

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1 **SUMMARY OF THE PRESENT INVENTION**

2 A multiple heat sensor alarm system for use in a vehicle to
3 indicate that the interior temperature is above a preset limit
4 and has a control head with a microprocessor. Heat sensors are
5 placed at different points in the vehicle and connected to the
6 microprocessor which averages the sensor inputs. When the
7 limit is exceeded the microprocessor issues an alarm command.
8 The system is connected to the vehicle components and the alarm
9 command operates the horn, lights (e.g. police emergency
10 lights), sirens, fans, windows, or engine. The system may
11 correspond to a portable beeper/pager. The microprocessor has
12 a sophisticated time delay algorithm for use on initial start-
13 up. The system also monitors the battery power of the vehicle
14 and indicates a low power situation, the system sets off an
15 alarm utilizing a power saving algorithm to enable notification
16 to the handler before the battery power is completely exhausted.

17 Accordingly, it is an objective of this invention to
18 provide an alarm system that correlates temperature data from
19 different locations in the vehicle to arrive at an average of
20 the ambient temperature. The alarm threshold is set to the
21 average ambient temperature, and also an individual sensor
22 temperature threshold.

23 It is a further objective of this invention to provide an
24 alarm system with a sophisticated time delay algorithm to allow

1 vehicle cooling after initial start-up.

2 Another objective is to provide monitoring of temperature
3 sensors and other alarm condition detectors to determine proper
4 operation, if a failure is found the alarm system displays the
5 failure and notifies the handler away from the vehicle.

6 Still another objective is to provide a system that
7 utilizes non-volatile memory, therefore all temperature alarm
8 thresholds and feature settings are retained even if system
9 power is interrupted or lost.

10 It is another objective of this invention to provide an
11 alarm system that includes visual read-outs which show the
12 temperature of each sensor.

13 A further objective of this invention is to provide a
14 control head connected to each sensor and to certain components
15 of the vehicle through the electrical system of the vehicle.
16 The control head includes switching to energize such components
17 as a K9 ventilation fan, the horn, the emergency lights (police
18 emergency lights), the siren, electric windows either
19 sequentially, simultaneously or as programmed, and optionally
20 the engine.

21 Yet another objective of this invention is to provide the
22 control head with capability to electronically send signals to
23 a portable device carried by the operator of the vehicle.

24 A still further objective of this invention is to provide

1 a vehicle battery monitor to signal a low voltage situation.

2 Another objective of the invention is to include auxiliary
3 alarm inputs to detect smoke and/or carbon monoxide.

4 Yet still another objective of the invention is to
5 interface to a police radio to announce by voice or data of a K9
6 alarm condition. Such an objective will enable the notification
7 of the alarm condition to a dispatcher, other officers and the
8 K9 handler if the handler is carrying a portable police radio.

9 Other objectives and advantages of this invention will
10 become apparent from the following description taken in
11 conjunction with the accompanying drawings wherein are set
12 forth, by way of illustration and example, certain embodiments
13 of this invention. The drawings constitute a part of this
14 specification and include exemplary embodiments of the present
15 invention and illustrate various objects and features thereof.

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1 **SHORT DESCRIPTION OF THE DRAWINGS**

2 Fig. 1 is a diagram of the multiple sensor heat alarm
3 system of this invention.

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5 **DETAILED DESCRIPTION OF THE INVENTION**

6 The multiple sensor heat alarm system 10 has a control head
7 11 and temperature sensors 12 and 13 connected by wires 14 and
8 15. The control head is connected to the vehicle electrical
9 system. The circuit includes the vehicle battery 16 so that the
10 system has power at all times. A battery pack separate from the
11 vehicle electrical system can be used, if desired, both as an
12 automatic back-up during periods of low vehicle battery power or
13 to energize the system 10 totally. There is a manual ON-OFF
14 switch 17 to disable the system and prevent draining battery
15 power.

16 The system 10 has a microprocessor 18 such as, for example
17 only, model PIC16F87X microcontroller marketed by Microchip
18 Technology, Inc. Of course, other microprocessors may be used
19 in the system. The microprocessor 18 is programmable and is set
20 by the user to a desired alarm temperature threshold. The
21 microprocessor may also be programmed to activate the different
22 vehicle components and installed alert options to notify the
23 operator that the average temperature is above the alarm
24 threshold.

1 The control head 11 has a microprocessor 18 that receives
2 the data from the temperature sensors 12 and 13 and decodes the
3 data to present a visual display of the temperatures at the
4 sensors. The temperature sensors are placed in or near the
5 containment area of a K 9 vehicle in such locations that both
6 will not normally be subject to the same temperature level. The
7 display shows both temperatures with a resolution of 0.1 degree
8 F. The microprocessor also averages, ie., totals the data
9 inputs and divides by the total number of temperature sensors,
10 and can simultaneously present the average as a third
11 temperature display. As the sun strikes the vehicle at various
12 angles, the vehicle will have natural hot spots which could
13 activate the alarm prematurely. The average temperature gives
14 a much more accurate sensing of the overall ambient temperature
15 inside the vehicle. The average is used by the microprocessor
16 as the data to drive the system and initiate the alarm sequence.

17 As an example of the algorithm used when temperature
18 averaging is enabled, the alarm threshold is set at 90 degrees
19 F of the multiple sensor average and is also set to 100 degrees
20 F of each individual temperature sensor. This significantly
21 reduces false alarms, while still monitoring for an extreme
22 temperature.

23 The temperature sensors 12 and 13 are digital thermometers,
24 such as model DS18S20, High Precision 1-Wire Digital

1 Thermometer, marketed by Dallas Semiconductor. Of course, other
2 digital and analog thermometers could be used in the system.
3 The sensors can be powered by the data line within the range of
4 3.0V to 5.5V. The sensors can measure temperatures with a ± 0.5
5 degree C accuracy from -10 to 85 degrees C. Non-volatile user
6 defined alarm settings can be programmed for addressing the
7 microprocessor when the temperature is outside programmed
8 limits. Using this system, one, two or more sensors can be used
9 with one microprocessor. The microprocessor uses a software
10 algorithm that doubles the accuracy of the digital temperature
11 sensor. If more than two sensors are placed in the system the
12 averaging will include all the temperature readings. The
13 sensors are placed in the vehicle in locations that will not
14 usually be, simultaneously, in a hot spot or direct sunlight.
15 The sensors are connected to a cable or data line that may be
16 about 15 feet in length. The temperature sensor is housed in a
17 custom designed brass enclosure thus making it much less likely
18 to be damaged by the contained canine, or other animal, while
19 allowing it to be placed in close proximity for accurate
20 temperature measurement.

21 The system has a self test function to monitor each sensor
22 and the associated wiring and connections. Any fault or failure
23 may be displayed as well as activating an alarm, as programmed.
24 An alarm is activated by a sensor failure.

1 Additionally, the system has a vehicle battery sentinel
2 mode. The programming of the microprocessor includes an
3 algorithm monitoring the vehicle battery voltage over time to
4 determine if the voltage is dropping at a certain rate and
5 exceeds a preset limit, it will issue a full alarm response for
6 a short period of time, such as 15 seconds. The period of time
7 is sufficient for lowering the windows 19 or the execution of
8 the slowest alarm function. The full alarm response activates
9 all the alarm devices, including the remote beeper/pager 21 via
10 a beeper/pager transmitter 20 located in the vehicle. After the
11 short activation, the system shuts down all the alarm devices,
12 except the beeper/pager transmitter 20, to conserve battery
13 power. After a predetermined rest period, another full alarm
14 response is activated. This sequence of short alarms and shut-
15 downs continue until manually stopped or power levels are
16 restored. The limit may be set at a level to assure enough
17 battery power to start the vehicle engine.

18 The output of the microprocessor 18 includes a display in
19 the control head such as digital LCD or analog readouts of all
20 temperature sensors. The preset temperature threshold for
21 activation of the alarm may also shown. The system may have its
22 own aural and/or visual alarm, in the control head, activated
23 by the microprocessor. Displays other than numeric may be used
24 such as bar graphs and an adjustable red line for the alarm

1 threshold temperature.

2 In addition, the system may have a RF transmitter 20 or
3 beeper/transmitter 20 and a small portable receiver or remote
4 beeper/pager 21 to be carried by the operator of the vehicle.
5 The microprocessor is programmed to send a signal to the
6 beeper/pager 21 via the beeper/pager transmitter 20 when the
7 temperature alarm threshold is exceeded. Or the system may have
8 a transmitter/receiver 20 in the control head, controlled by the
9 microprocessor, to send and receive a signal or data when the
10 temperature is excessive or information about the alarm system
11 or vehicle or data to and from a remote two-way beeper/pager or
12 device 21. The remote two-way beeper/pager or device 21 could
13 send a return signal to the microprocessor to stop the alarm or
14 perform some additional function, such as opening the windows or
15 doors. This permits the operator to stop the alarm in the
16 event he is immediately returning to the vehicle or, in case he
17 is detained, to otherwise control the temperature in the
18 vehicle.

19 Further, the microprocessor 18 may be programmed to track
20 the operation of the vehicle engine 22. In some situations, the
21 handler may leave the vehicle engine running to maintain a
22 healthy temperature and, in the event the engine stalls or stops
23 running, the microprocessor may send an alarm command. The
24 alarm command may activate the vehicle components or the remote

1 beeper/pager 21 or both. Also, the system can have the ability
2 to start the vehicle engine 22 to operate the air conditioning
3 unit upon reception of a remote signal.

4 The use of an interactive beeper/pager signal device 21 may
5 roll down or unlock and unlatch a window(s) 19 or door(s) 23 to
6 permit a trained animal to escape the vehicle. The remote
7 beeper/pager 21 has one button 24 to initiate the unlock/unlatch
8 sequence to avoid confusion in a high stress situation. The
9 microprocessor controls the timing of the unlock/unlatch
10 sequence to avoid destructive heat build-up in the door solenoid
11 (not shown) in the event the operator holds the button down.
12 The microprocessor 18 controls the signal to the solenoid that
13 is interfaced with the doorjamb mechanism of the vehicle and
14 mimics the action of the door handle. For example, after
15 receiving a remote signal the microprocessor is programmed to
16 send power to the door lock/unlock motor; pause; send power to
17 unlatch solenoid; pause; send power to unlatch solenoid; pause;
18 repeat sequence if remote signal is received; if no remote
19 signal stop.

20 The output can be integrated with other vehicle components,
21 such as a fan 25, the horn 26, the lights 27, the light bar 28,
22 in a police or emergency vehicle, the windows 19, and the engine
23 22. These components may be energized by an alarm signal from
24 the microprocessor 18. The microprocessor may be programmed to

1 activate the horn and/or lights in a particular sequence or tone
2 to attract the operators attention.

3 Unique to this invention is the use of the microprocessor
4 to activate the horn and/or lights in a particular sequence or
5 tone to attract the operators attention. For instance, the
6 Morse code SOS can be utilized to give an emergency signal with
7 horn or lights.

8 The microprocessor 18 has a delay built into the alarm
9 circuit which is operative upon initial activation of the
10 system. Initial activation of the system may be the use of the
11 manual OFF/ON switch 17 or the system may have a connection to
12 the ignition system to receive an indication that the engine has
13 been started. The delay prevents the alarm(s) from being
14 automatically activated when the vehicle is started after being
15 vacant and the temperature being above the alarm threshold. The
16 delay allows time for the air conditioner and/or open windows to
17 dissipate the ambient heat before the alarm is activated. The
18 amount of time in the delay may be programmed depending on the
19 locale.

20 The delay has two modes. An auto mode is programmed in the
21 starting sequence. For example, the auto mode may have a 3
22 minute time limit. During this auto cycle, the system may emit
23 an aural signal and a flashing pre-alarm visual warning in the
24 display. An aural signal and the visual display change will

1 indicate if at the end of the 3 minute period the temperature is
2 still above the alarm threshold. If the operator determines
3 that the vehicles interior temperature is decreasing but
4 requires more time, the operator may initiate an additional 3
5 minute delay. This manual mode reset restarts the timer for
6 another 3 minutes however, the number of manual resets is
7 limited to only a few times. If the vehicle is vacant or the
8 operator takes no action and the interior temperature is still
9 above the alarm threshold, the microprocessor will go into the
10 alarm mode. Most often, the system is setup to be powered ON
11 when the vehicle's ignition is ON and powered OFF when the
12 ignition is OFF. This is the "active setup" whereas the
13 operator will leave the engine running and the A/C ON to
14 maintain a cool environment when he/she leaves the animal
15 unattended in the vehicle. In this setup the operator is not
16 required to remember to enable or disable the alarm system.
17 However, in more moderate climates the system may be setup to be
18 left powered ON even if the ignition is OFF. This is a "passive
19 setup" whereas the operator may leave the animal in the vehicle
20 unattended WITHOUT leaving the engine running and the A/C ON
21 thus actively maintaining a cool interior of the vehicle. This
22 is done in moderate climates usually with the windows down to
23 passively ventilate the animal. Of course, a strong window
24 screen or other cage system is used to keep the animal contained

1 within the vehicle. If while the operator is away the climate
2 changes or the sun's effective radiance changes in a way that
3 the passive ventilation can not dissipate the heat within the
4 vehicle, the alarm system senses the interior heat rise and
5 activates the various alert systems.

6 Once the system is placed in a vehicle and is operative,
7 the alarms will function whether or not there is an occupant in
8 the vehicle. The manual heat sensor system switch is important
9 to inactivate the system for an empty vehicle. The preferred
10 embodiment is installed to be automatically energized unless
11 manually turned off because it was found that if the system
12 required manual activation, the activation of the system was
13 overlooked too often.

14 The system can be installed in any vehicle with an
15 electrical system, such as cars, vans, trucks, ambulances,
16 buses, etc., and the occupants may include those species
17 deleteriously affected by a high ambient temperature.

18 A number of embodiments of the present invention have been
19 described. Nevertheless, it will be understood that various
20 modifications may be made without departing from the spirit and
21 scope of the invention. Accordingly, it is to be understood
22 that the invention is not to be limited by the specific
23 illustrated embodiment but only by the scope of the appended
24 claims.